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METHOD AND DEVICE FOR MONITORING THE INTERIOR AND SURROUNDING AREA OF A VEHICLE

Sub A1

Background of the Invention

The invention is based on a method according to the definition of the species set forth in the main claim. The article "Die neuen Augen des Autos, Limousinen lernen lesen [Cars Get New Eyes, Limos Learn to Read]" ~~in~~ as the journal *Bosch Zünder*, ~~October 1998 issue, page 8~~, describes a method in which the area in front of the driver surrounding the vehicle is monitored by two video cameras. The image captured by the cameras is ~~then~~ evaluated with regard to road signs that can be detected in the Then, the road signals are ~~image, which are then~~ displayed to the driver via a display unit. In addition, the system captures the path of the road in order to control the direction of the headlamps so that the light cone falls on the road. If the car enters the shoulder, an audible and/or visual warning is triggered. Furthermore, a method that ~~which~~ measures brain activity, in particular of the driver of a vehicle, and ~~which~~ triggers an alarm if there are deviations from the normal awake status, is described in PCT patent no. ~~known from~~ WO 93/21615. Herein, measurements are taken via electrodes placed on the driver's head.

SUMMARY

~~Advantages of the Invention~~

The ~~By contrast, the~~ method according to the present invention has the ~~having the features set forth in the main claim has the~~ advantage that the interior of and ~~as well as~~ the area surrounding a vehicle can be captured using just one camera device. In particular, this is feasible because the interior of the vehicle and the area surrounding the vehicle are captured alternately. Provided the system alternates sufficiently quickly between capturing the interior and capturing the surrounding area, loss of information arising from switching back and forth may be ignored, and just one camera device as opposed to two is required for the interior and the area

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only captures the road markings, is ~~achieved~~ increased. For example, when the vehicle is traveling in a straight line for a long period, the vehicle may travel for ~~some~~ a considerable time within the road markings, even though the driver has already been asleep for a number of seconds. Using the method according to the present invention, it is possible to detect that the driver has fallen asleep in a case of this kind.

If the camera is used for monitoring, it is not necessary to place electrodes on the driver's body, which is necessary in the case of the method in which the driver's brain waves are monitored. ~~Because~~ Since electrodes of this kind may be cumbersome and may limit the driver's freedom of movement, and ~~because~~ the driver may also forget to put them on when he starts driving or may deliberately not put them on because they are uncomfortable, a warning indicating that the driver has fallen asleep is easier to implement and less unpleasant for the driver to use. Furthermore, the method according to the present invention has the advantage that as well as monitoring the interior, the system can capture road signs in the area surrounding the vehicle and can therefore alert the driver, for example, to warning signs or speed limit signs via a visual or acoustic output unit.

Furthermore, it is advantageous to determine the number of people in the vehicle or, respectively, the seat occupancy. This information can be used, for example, to control the chassis so as to compensate for an uneven load in the vehicle if, for example, people are only sitting on the left side of the vehicle, ~~namely~~ for example the driver and one person behind him. Furthermore, this information can be use to control a seat heater, ~~heater~~ which is only activated if someone is actually ~~using~~ sitting on the seat. ~~In particular~~ For example, it is possible to determine whether a seat is occupied or is occupied by a child seat, as it is advantageous that deployment of an airbag can be blocked if a seat is unoccupied or is occupied by a child seat. As a result, unnecessary deployments of an airbag can be avoided if

Furthermore, it is advantageous to design the camera as, for example ~~as~~ a CCD camera or a CMOS camera. As a result, the camera device according to the present invention can be designed ~~particularly~~ inexpensively. Furthermore, it is advantageous to equip the camera device with at least two cameras, so that stereoscopic image capturing is possible, and so that conclusions can be drawn regarding the distances between the vehicle and objects, ~~objects~~ and distances in the interior, respectively, by evaluating distance-dependent image shift.

In addition, it is advantageous to arrange the camera device in an upper part of the windshield or to integrate the camera device into the roof of the vehicle. A position at least close to the vehicle roof allows an especially good overview of the area surrounding the vehicle and ~~of~~ the vehicle's interior.

Furthermore it is advantageous to design at least one deviation mirror so that it can be adjusted by an adjustment device so that at least the eyes and/or lips of the driver can be captured by the camera. This is ~~particularly~~ useful if drivers alternate and are of different heights and may arrange the seat in different positions. Furthermore, it enables the driver's movements while driving to be taken into account. By designing the deviation mirror so that the visible range captured can be readjusted, it is possible to ensure that the driver's eyes and/or lips are always within the capturing area of the camera device. This ensures that the means for monitoring whether the driver has fallen asleep and the means for checking speech input function properly, especially during driving.

Sub A4

Drawings

Exemplary embodiments of the present invention are shown in the drawings and are described in greater detail below. Figure 1 shows an arrangement of the device according to the present invention in a motor vehicle; Figure 2 shows a flow chart of the method according to the present invention; Figures 2a and

2b show details of the method according to the present invention; Figure 2c shows an evaluation method according to the present invention; Figure 3 shows a flow chart for a further embodiment of the method according to the present invention; Figure 4 shows an embodiment of the device according to the present invention; Figure 5 shows another embodiment of the device according to the present invention; Figure 6 shows another embodiment of the device according to the present invention; Figure 7 shows a further embodiment of the device according to the present invention; and Figures 8a and 8b show embodiments of a deviation mirror according to the present invention.

Description of the Exemplary Embodiments

In Figure 1, a camera device 10 according to the present invention is arranged in a motor vehicle on upper edge 11 of a windshield 12. The camera device has a first optical opening 13. A ~~13, a~~ first beam path 14 leading to a driver 15 of the vehicle. The mid-point beam of the beam path is shown. In addition, camera device 10 has a second optical opening 16, which is arranged on the side ~~opposite side~~ of camera device 10 opposite to first optical opening 13 and is therefore, not visible in the view shown in the drawing. Therefore, second ~~Second~~ optical opening 16 is ~~therefore only~~ shown using a broken line. In addition, a second beam path 17, which leads from second optical opening 16 of camera device 10 through windshield 12 into the area surrounding the vehicle in front to the vehicle, is shown. The driver's line of sight, which is shown as a third beam path 18, extends in the same direction. Furthermore, cockpit 19 of the vehicle has a steering wheel 20 and a display unit 21. Herein, display unit 21 is embodied as, for example ~~preferably embodied as~~ a combination instrument in which a plurality of displays are integrated into one electronic unit. For example ~~In particular~~, a freely programmable combination instrument, in which various display instruments are shown on a screen, e.g., in the form of a liquid crystal display, is feasible. The figure also includes a processing units ~~unit~~ which processes the image information

recorded by camera device 10, but this is not shown separately. The processing unit may [illegible] ~~either be arranged in~~ the housing of camera device 10 shown, ~~or in~~ the vehicle roof on the other side of upper edge 11 of the windshield, or ~~in~~ cockpit 19 of the vehicle. In an ~~a preferred~~ exemplary embodiment, the processing unit is arranged in a part of display unit 21 that is not visible to driver 15. As display unit 21 is used to output visual warning signals that are based on the evaluation by the processing unit of the image information recorded by camera device 10, e.g., if the driver is about to fall asleep or has exceeded the maximum speed limit, long data transmission paths can be avoided.

Camera device 10 is arranged in the upper part of windshield 12 close enough to the vehicle roof (not shown) so that the vehicle interior and the road in front of the vehicle can be monitored effectively. therefore, ~~Preferably~~ the camera device ~~therefore~~ is arranged, for example ~~arranged~~ in the middle of the vehicle with respect to the sides of the vehicle. It is also feasible for it to be arranged in the left upper part of windshield 12 in a left-hand-drive vehicle, as this ensures that not only the driver but also the entire road can be effectively captured by the camera device. In a right-hand-drive car, the camera is arranged in a right upper section of windshield 12. First and second optical openings 13, 16 may be designed in various ways. Any of the following ways are feasible: A filter, an opening, a lens, or a combination thereof in which the aforementioned components are arranged behind one another.

Figure 2 shows a flow chart for the method according to the present invention. Starting from an initialization step 30, in a first process step 31 first image information 32 of the surrounding area is captured and evaluated by the processing unit. A ~~unit, a~~ first output 33 is output ~~being output~~ via visual and/or acoustic output media based on first image information 32. Thus the first output is based on the area surrounding the vehicle. In a subsequent second process step 34, image

information regarding the vehicle interior is determined from second image information ~~35, in which~~ 35. In second process step 34, superimposed image information regarding the surrounding area and the vehicle interior is captured, based on first image information 32 regarding the surrounding area obtained ~~previously~~, by subtracting first image information 32 from second image information 35, so that based on the image information ~~obtained~~ a second output 36 is obtained and output ~~also output~~ via visual and/or acoustic output media. The second output is ~~media, the second output being in particular~~ dependent on the image information regarding the vehicle interior. In a subsequent decision step 37, the process is aborted if the camera device is deactivated, i.e., ~~in particular~~ if the vehicle is turned off. This decision path is shown as Y in the drawing. In this case, the process ends when the camera device is switched off in a subsequent process step 38. If the vehicle is not turned off, processing branches back to first process step 31. This decision path is shown as N in Figure 2.

In Figure 2a, first process step 31 is shown in detail. In a first sub-step 40, the camera device is switched on and first image information 32 is recorded. In a second sub-step 41, first image information 32 is sent to the processing unit for further processing.

In Figure 2b, second process step 34 is subdivided into sub-steps. In a first sub-step 42, the radiation source that is not visible to the human eye is switched on by being supplied with electrical voltage. In a second sub-step 43, camera device 10 is switched on and a superimposed image of the interior and ~~of~~ the surrounding area is captured as second image information 35. In addition, a lighting adjustment must be performed ~~carried out~~ based on the lighting conditions, e.g., via an adjustable diaphragm opening or adjustment of the current applied to the light-sensitive sensors of the camera device. In a third sub-step 44, after the image has successfully been recorded, second image information 35 is stored and sent to

the processing unit for further processing. In a fourth sub-step 45, the radiation source that is not visible to the human eye is switched off. The image of the interior is then determined in a processing step (not shown in Figure 2b) in the processing unit.

Figure 2c shows an evaluation process carried out by the processing unit ~~which~~ that includes processing of the image information recorded by the camera device ~~device and of~~ first output ~~33~~ 33, and second output 36, respectively. An example of an evaluation process is a falling-asleep warning generated by monitoring driver 15, monitoring of the vehicle's interior being necessary and second output 36 consequently being output. A method for detecting the surrounding area, e.g., for detecting road signs and/or road markings, can be embodied in a similar manner, first output 33 being output.

In a first initialization step 50, the processing unit obtains an image of the driver's eye section from first and second image information 32 and 35. In a first decision step 52, the recorded image is compared with image information 51 regarding the driver's eye section that has been stored previously. Herein, image information 51 is an empty image if the vehicle has just been started up and as yet no image information has been stored. If it is determined that the driver's eyes are open, i.e., the driver is not asleep, or if image information 51 is an empty image, processing branches along decision path N, and in process step 53 the recorded partial image is stored. Furthermore, the fact that the driver is awake at the time the image was recorded is stored in another memory. The evaluation process is ended in a completion step 54. The evaluation process is started again the next time first and second image information 32 and 35, respectively, are transmitted to the processing unit. A new start is performed ~~carried out~~ each time the evaluation process ends provided the vehicle or the camera device have not been switched off.

If the processing unit determines that the driver's eyes are closed, processing branches from first decision step 52 to a second decision step 55 along decision path Y. Here, a check is performed to determine whether the driver's eyes were already closed the last time an image was recorded. If not, processing branches to a sub-step 56, where data is stored indicating that the driver's eyes are closed at the point in time the image was recorded. In a completion step 57, the evaluation process is ended. If the driver's eyes were already closed the last time an image was recorded, processing branches along decision path Y from second decision step 55 to a first warning step 58. This warning is an audible warning and/or a visual warning, for example ~~preferably~~ via display unit 21. Because a warning is not issued until a second image has been recorded and thus after second decision step 55, it is generally possible to avoid a situation where a warning is issued because, by chance, the image was taken exactly at the moment the driver blinked, thus causing camera device 10 to detect that the driver's eyes are closed.

After first warning step 58, a third decision step 59, in which image information 67 regarding a further image of the driver's face section is taken into account, is performed ~~carried out~~. If the driver's eyes have reopened, processing branches along decision path Y to a processing step 60, and image information 67 that has been newly recorded is ~~being~~ stored. Furthermore, data indicating that the driver's eyes are open is stored in a memory. The evaluation process is ended in a subsequent completion step 61. However, if the driver's eyes are still closed, processing branches from third decision step 59 along decision path N to a second warning step 62. In second warning step 62, a significantly louder audible warning is issued than that issued in first warning step 58. In a fourth decision step 63, image information 68 regarding the driver's facial section is captured again and status 69 of a switch is queried. If it is determined that the driver's eyes are now open or if the driver operates the switch, processing branches

along decision path Y. In a first sub-step 64, data indicating that the driver's eyes are open is stored and the evaluation process is ended in a completion step 65. If it is not determined that the driver's eyes are open or if it is not determined that the switch has been triggered, processing branches along decision path N to a third warning step 66. A loud audible warning is now issued again, and the vehicle is decelerated, the hazard warning lights system and the brake lights being activated so that driverless driving is avoided. As there are circumstances in which the camera device cannot obtain an image of the driver's eyes, e.g., if he is wearing sunglasses, the process shown in Figure 2c can be deactivated.

Furthermore, it is possible to increase the number of times the image information regarding the driver's eye section is queried before an appropriate warning step is performed ~~carried out~~, so as to avoid incorrect issuing of warnings. Herein, the number of queries is based on how frequently image information regarding the interior is captured. The process shown in Figure 2c may also be used to monitor the vehicle's position relative to a road marking if, instead of capturing image information regarding the driver's facial section, image information regarding the road marking is captured and the vehicle's position relative to the road marking is evaluated.

Figure 3 shows a further method according to the present invention for monitoring the area surrounding the vehicle and the vehicle interior. The same reference numbers represent the same process elements as those in Figure 2. Following an initialization step 30, in a first process step 80 first image information 81 regarding the vehicle's surrounding area is determined, sent to the processing unit, and first output 33 is output based on first image information 81. In second process step 82, second image information 83 regarding the interior is captured by the camera device and sent to the processing unit. Second output 36 is output based on the image information captured. During first process step 80, an

electro-optical light valve in the direction of the vehicle's surrounding area is opened. In second process step 82, an electronic light valve in the direction of the vehicle's interior is opened. After second process step 82, a decision step 37 is performed ~~carried out~~. If the camera device is switched off, processing branches along decision path Y and the camera device is switched off in a subsequent process step 38. Otherwise, processing branches back to first process step 80 via decision path N. Herein, in a an ~~preferred~~ exemplary embodiment, in first and second process steps 80, 82 the light valve in question is only opened for 90% of the duration of the process step in question. This ensures that the two sets of image information to be recorded do not overlap. For example ~~Particularly~~ at low temperatures, this keeps the image information to be recorded from overlapping, as low temperatures may cause the liquid crystal's switching behavior to become sluggish. The evaluation process described in Figure 2c can be applied directly to the first output and/or second output 36 in Figure 3.

Figure 4 shows an embodiment according to the present invention of a camera device 10 that has ~~having~~ a processing unit 110. Camera device 10 is arranged in a housing in which a camera 100, which is designed as, for example ~~as~~ a CCD camera or a CMOS camera, is arranged with a first lens 101. Light from a first deviation mirror 102 enters first lens 101. First deviation mirror 102 is semi-transparent, so that a first beam path 103 from the vehicle's surrounding area passes through an opening 109 in the housing of camera device 10, then passes through first deviation mirror 102 and then through first lens 101 to camera 100. Furthermore, a second beam path 108 from a second deviation mirror 104 travels to first deviation mirror 102. Second beam path 108 is deviated by first deviation mirror 102 and travels to camera 100. Second beam path 108 travels from the vehicle interior and enters camera device 10 through a second lens 107. Before it reaches second deviation mirror 104, it passes through an infra-red filter 106. Camera 100 is

connected to processing unit 110 via a first data circuit 111. Processing unit 110 includes a control unit 112 and an evaluation unit 113, which are connected to one another via a second data circuit 114. Evaluation unit 113 is connected via a third data circuit 117 to sensors 116 and via a fourth data circuit 118 at least to audible and/or visual display elements 119. Furthermore, control unit 112 is connected via a fifth data circuit 120 to camera 100 and via a sixth data circuit 122 to a radiation source 121, which emits radiation that is invisible to the human eye. Radiation source 121 is arranged in a housing, which, for example, is ~~housing which is preferably~~ designed as a reflector 123.

First beam path 103 and second beam path 108 are denoted by the optical axis of the beam in question. Here and in Figures 5-7, only the midpoint beam, which represents the entire beam path, is shown. In front of lens 101, the optical axis of the two beam paths coincides. However, for the purposes of clarity, in Figure 4 and the subsequent figures we have shown the two beam paths in parallel.

Processing unit 110 and camera device 10 may also be arranged in a single housing near the vehicle roof i.e., near the upper edge of windshield 12. However, processing unit 110 and camera device 10 may also be arranged in different places within the vehicle. In an ~~a preferred~~ exemplary embodiment, processing unit 110 is integrated into display unit 21.

In first process step 31 of ~~in~~ Figure 2, an image of the vehicle's surrounding area is captured by camera 100 with the help of first beam path 103. Herein, the image captured depends on how camera device 10 is arranged in the vehicle, and also on the size of opening 109 in the housing of camera device 10, and also on the setting of first lens 101. Herein, opening 109 ~~preferably~~ has a transparent cover, e.g., a transparent plastic disk. Furthermore, a third lens may be arranged there. When second process step 34 is performed ~~carried out~~, in first sub-step 42 radiation source 121 is switched on by

control unit 112 via sixth data circuit 122 for the duration of the time period during which the image is captured. This ~~captured, this~~ is ~~being~~ accomplished by applying a voltage to radiation source 121. Figure 4 does not show the voltage source. The beam, which is bundled by reflector 123, is radiated into the vehicle's interior. The beam that is radiated is invisible to the human eye. The ~~Preferably the~~ radiation source is designed as, for example ~~as~~ an infra-red beam diode or an infra-red beam diode array that includes a plurality of infra-red beam diodes. If the interior of the vehicle is illuminated by radiation source 121, the infra-red radiation that is reflected in the vehicle's interior passes through second lens 107 along second beam path 108 into camera device 10 and reaches infra-red filter 106. This filter only allows infra-red radiation through ~~through infra-red radiation~~, so that visible light from the vehicle interior does not reach camera 100. Thus, for example ~~Thus in particular~~ it is possible for the vehicle interior to be captured independently of visible light. Illumination of the interior is ~~thus~~ only dependent on the intensity of radiation source 121. Thereafter, the filtered infra-red radiation passes to second deviation mirror 104, then to first deviation mirror 102, then to first lens 101 and into camera 100. Second deviation mirror 104 has an adjustment device 30. In the figure only a mounting 130 of this adjustment device is shown. An electric motor, a control unit and a power supply are not shown. With the help of this adjustment device, second deviation mirror 104 can be rotated about an axis of rotation 131 within a certain angular range. As a result, the area of the interior, ~~interior~~ which is imaged by second lens 107 and via the second deviation mirror into camera 100, ~~100~~ can be modified. This is particularly useful if a driver changes the position of his seat while driving and camera device 10 must continue to capture his facial section.

Sensors 116 may be designed as, for example, seat sensors, which supply information as to whether a seat is occupied. If a seat sensor reports that a seat is unoccupied, the camera can check whether this is true or whether there is movement,

for example, on the seat indicating that the seat is in fact occupied. In such cases, an airbag is not deactivated and/or seat heating is not deactivated. Furthermore, sensors also ~~mean~~ include input elements via which, for example, a falling-asleep warning can be deactivated if the driver is wearing sunglasses ~~which mean that~~ since, his eyes cannot be seen by camera 100. Output units ~~mean~~ include audible and/or visual warning elements that may be embodied ~~as~~ as, for example a loudspeaker, a warning light or a liquid crystal display. Evaluation unit 113 and control unit 112 may also be integrated in a device. Furthermore, control unit 112 controls the position of second deviation mirror 104 via a connection line (not shown), based on instructions transmitted from evaluation unit 113 via second data circuit 114. If an object being monitored by camera device 10 threatens to move beyond the visible range, the processing unit can in this way modify the visible range via the control means of the second deviation mirror. First data circuit 111 and fifth data circuit 120 constitute a connection between camera device 10 and processing unit 110. Herein, first data circuit 111 is used to transmit image information from camera 100 to processing unit 110, in particular to evaluation unit 113. Processing unit 110, in particular control unit 112, controls camera 100 via fifth data circuit 120. First data circuit 111 and fifth data circuit 120 may also be combined as a single data circuit.

Figure 5 shows a further exemplary embodiment according to the present invention of the device for monitoring a vehicle's surrounding area and the vehicle interior. Here and in the subsequent figures, once again the same reference numbers denote the same components. In Figure 5, second beam path 108 leaves the housing of camera 10 after passing through infra-red filter 106. In Figure 5, in order to distinguish the housing of camera device 10 from infra-red filter 106, we have shown the former using a broken line. The embodiment shown in Figure 5 allows the camera device to be arranged parallel to the sectional plane and perpendicular to the vehicle roof. In

an ~~a preferred~~ exemplary embodiment, in which camera device 10 is arranged perpendicular to the vehicle roof, the area around the camera as far as opening 109 is completely housed in the vehicle roof, while the area around the second deviation mirror protrudes into the vehicle interior, i.e., the sectional plane in the drawing is perpendicular to the vehicle roof. Aside from adjustment of second deviation mirror 104, essentially the optical properties of first lens 101 are used to produce an image in camera 100.

In Figure 6, a further embodiment according to the present invention of the device for monitoring a vehicle's surrounding area the vehicle interior is shown. In this exemplary embodiment, camera 100 is arranged on a different side of first deviation mirror 102 from that in Figures 4 and 5. In this case, the light that follows first beam path 103 is reflected by first deviation mirror 102 onto camera 100. By contrast, the light that follows second beam path 108 is deviated by second deviation mirror 104, so that the beam passes through first deviation mirror 102, which is embodied as, for example ~~as~~ a semi-transparent mirror, and ultimately reaches camera 100. Furthermore, in this exemplary embodiment reflector 123 is integrated into the housing of camera device 10, thus saving space. However, radiation source 121 may also be arranged in a favorable position in the vehicle some distance away from camera device 10. In addition, a plurality of radiation sources may be provided in the vehicle to ensure the vehicle's interior is optimally illuminated.

Figure 7 shows a device for performing ~~carrying out~~ the method according to the present invention described in Figure 3. Instead of opening 109, an electro-optical light valve in the form of a first liquid crystal cell 151 is placed in first beam path 103. First liquid crystal cell 151 can be controlled by control unit 112 via a control line 150, so that it is possible to switch first liquid crystal cell 151 back and forth between a transmissive and an absorptive state. The

structure of the liquid crystal cell is not shown in detail in the drawing, nor is the power supply shown. Herein, first liquid crystal cell 151 may be embodied so that a liquid crystal between two glass substrates is arranged between two transparent electrodes and influences the polarizing direction of light in different ways based on an electrical field that is applied. By arranging polarizing films on the glass substrates, it is possible to establish a desired level of absorption of light based on the voltage applied to the transparent electrodes or, respectively, a predefined maximum transmission of light based on the glass substrate, the polarizers and the liquid crystal. Furthermore, a second liquid crystal cell 153 is provided that ~~provided,~~ can be controlled by control unit 112 via a control line 152 and is arranged in second beam path 108. In first process step 31, first liquid crystal cell 151 is switched over to a transparent state and second liquid crystal cell 153 is switched over to an absorptive state. In this case, only the light from the vehicle's surrounding area enters camera 100 along first beam path 103. In second process step 34, first liquid crystal cell 151 is then switched over to its absorptive state and second liquid crystal cell 153 is switched over to its transmissive state. In this case, light passes along second beam path 108 through a third lens 154 and via second deviation mirror 104 and first deviation mirror 102 into camera 100. In order to avoid overlap, an intermediate step in which both liquid crystal cells 151 and 153 are switched over to their absorptive state may be inserted between the two process steps. This is recommended in particular at low temperatures, because in such cases switching over of the liquid crystal may be subject to a delay and maximum absorption and transmission, respectively, are ~~is~~ not reached until the electrical field has been present for some time. By contrast with the exemplary embodiments shown in Figures 4 to 6, in the device shown in Figure 7 visible light also enters camera 100 along second beam path 108.

Furthermore, in the case of all the aforementioned exemplary embodiments, two closely adjacent cameras, ~~cameras~~ whose first and second beam paths are offset slightly relative to one another, ~~another~~ may be provided instead of single camera 100. This allows images to be captured stereoscopically. With the help of suitable calculations performed by evaluation unit 113, conclusions regarding the distances to individual objects can be drawn from the captured stereoscopic images. This is advantageous in the case of detection of objects, e.g., road signs.

Figures 8a and 8b show exemplary embodiments of second deviation mirror 104. In Figure 8a, a second deviation mirror 1041 is concave, and in Figure 8b a second deviation mirror 1042 is convex. It is feasible to use either deviation mirror 1041 or deviation mirror 1042 as a second deviation mirror 104. Because the mirror is embodied in this way, the area visible to the camera can be modified. The mirror shown in Figure 8b can be used to enlarge the beam area, whereas the mirror shown in Figure 8a can be used to limit the beam area; this is accomplished due ~~thanks~~ to the differing curvature of the respective mirrors.